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ON THE ORIGIN AND IMPORT OF THE IDEA OF CAUSALITY.[1]

MORE than a hundred and fifty years have elapsed since David Hume, in his critical inquiries concerning the human understanding, subjected to exhaustive scrutiny the idea of causality. The impoverishment of this idea, the restriction of its meaning which Hume's analysis proclaimed, reposed on a peculiar view of the genesis of this notion. This latter study had since Locke been regarded as the safest method of establishing the epistemological value of ideas. The epistemological value of an idea is determined by the amount of reality entering the idea. Reality is synonymous with that which may be made the subject of direct experience, with that which is perceived, and not with that which is represented or thought,—in fine, with what Hume called *impression* as distinguished from *idea.* And every critical examination of ideas necessarily goes back in the end to the question: What definite experiences, what impressions lie at the bottom of them? Hume, as we know, subjected to the test of this logical reagent a large number of ideas, and with regard to all of them came to the same sceptical conclusion,—that in the popular as well as in the scientific usage these ideas had far more intellectual contents than could be warranted by their actual cognitive or experiential elements, and consequently that this surplus was more a product of imagination than of reason, more fancy than knowledge.

Of all the ideas which Hume investigated, that of causality is unquestionably the most important. It is the cardinal notion in the comprehension and arrangement of all the changes which we experience—a leading concept both in the physical and in the mental sciences. Our whole scientific world-view is determined by the meaning we give to it. Precisely at this point, moreover, has the influence of Hume's criticism been particularly lasting. Both science and philosophy have bowed to his arguments, and, so, have lapsed into a species of habitual scepticism for which in the nature of the case there was no real foundation. The irrefutability of Hume has grown into a virtual dogma, and it will doubtless repay the trouble, as it generally does in such cases, to submit this dogma to searching and exact analysis.

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[1] Translated from Professor Jodl's manuscript by Thomas J. McCormack.

According to the notion of causality, as it was commonly accepted in the popular and scientific thought of Hume's time, a change occurring in nature was interpreted as having its origin in an antecedent change or motion connected therewith in time, as being effected by its antecedent, or as being *necessarily* conjoined with it. On the basis of his analysis now, Hume excludes from the contents of this idea all connexion among the things themselves, all objective connexion, as also the necessity of such connexion; he leaves nothing standing but a connexion of ideas and the *feeling* of a certain necessity in this connexion, that is, a subjective connexion. Causality, says Hume, implies no connexion of things, for this would require that some special perception should be given us of the bond which links two phenomena together. But nothing of this sort has ever been observed. The impressions on the basis of which we causally connect two phenomena never present anything more than regular succession. Nor does causality involve connexion by virtue of the contents of the conjoined ideas, somewhat as we are able to develop a system of geometrical properties from the ideas of the circle, radius, and tangent. There is no logical connexion involved. For no one can infer from the idea of a thing what its effects must be, or what it has been the effect of. Our causal judgments are dependent entirely on experience. But this furnishes us with nothing but regular succession, and this alone gives rise to the so-called necessity of causal connexion, which is merely a habit or propensity of our imagination to associate regularly succeeding ideas, to pass from the one to the other, to expect or to foretell from the one the other.

So much for the sceptical arguments of Hume. Of their extraordinary influence I have already spoken. The entire Kantian philosophy, wherever its influence reaches, is almost completely dominated by them. Neither Kant nor his followers ever ventured to assert in contravention of Hume that causality could imply a necessary connexion in the objective world. Their sole makeshift was the ennobling, I might say, of what was substituted for this objective connexion. They made out of a habit of the imagination, out of a law of association, a primitive and original function of the understanding—a category. But it is clear that this statement of the problem of knowledge is in no essential point an advance on Hume. For the word *knowledge* bears its right meaning only when what is so called produces in us a consciousness of objective relations. But universal subjectivity is not the same as objectivity. An order of things proceeding *solely* from innate functions of the mind would be a conceptual architectonic figment, possibly of great rigidity and regularity,—a system of necessary illusions of the race, but not knowledge. It is a matter of course that all knowledge is partly mediated by consciousness, is a joint action of the ego and the non-ego. Absolute knowledge—that is, such as would be at the same time the thing itself—does not exist. All knowledge is a blending, a unification of the ideal and the real.

But not only Kant and Kantians of all shades down to Fr. A. Lange and Fr. Zöllner have surrendered unconditionally to Hume. H. Lotze also advances substantially the same ideas and teaches the doctrine of the unessential character of all causal relations for thought and the impossibility of discovering a bond between cause and effect. And when he attempts to overcome this isolation of the single elements of the world by assuming that they are all members of a single being and unitary substance, surely this is equivalent to seeking in remote metaphysical cloudlands truths which lie unnoticed at our feet. For inasmuch as all things in the world are far from being causally connected with all other things but in all cases definite effects only are dependent on definite causes, therefore the substantial unity of the world cannot enlighten us regarding the validity of our causal judgments and their epistemological value—but in reality the connexion sought is to be found in more proximate regions, namely, in the order and happenings of the actual world.

For certainly—to set the matter at once aright—the truth does not lie in the direction indicated by Kant, nor by Kantianism and the idealistic metaphysics. This line of thought, far from leading away from scepticism, actually plunges thinkers deeper and deeper into it, finally landing them by a perfectly intelligible reversion in mysticism. The truth does reside in empiricism, but it requires for its discovery a more searching examination of experience. The empiricism of Hume is not too much empirical but too little empirical. His description of the facts of experience is not exact enough. He jumps too frequently to constructions. I shall now set about demonstrating my assertions in detail.

Hume had asked in what fact of immediate experience, in what impression is the connexion between two phenomena given which we have in mind when we say that they are causally united. He had answered, there is no such impression. The phenomena, or the ideas representing them, are absolutely distinct ; there is no bridge leading from the one to the other, except that of custom. The causal law is nothing but the law of our psychological mechanism.

Is this a perfectly exact and apposite description of the facts? Whoever replies in the affirmative is irrevocably a captive of Hume's reasoning and can escape his conclusions in appearance only, or by extremely artificial devices. It is my belief, however, that this question must be answered in the negative. Misled by certain prejudices of the philosophy of his time, Hume did not rightly envisage the facts which led to his theory. What were those prejudices? Locke in his examination of the human understanding proceeded from an assumption which also thoroughly dominates Hume's inquiry: that the original, *actual* path of development of consciousness was the same as that of psychological analysis, only contrary in direction. Psychological analysis dissects the contents of consciousness, separates the individual phenomena from one another, and endeavors to apprehend their simplest and most primitive forms of appearance. No one will deny the value of such inquiries, nor of the profound vistas which they afford into the hidden mechanism of consciousness. But psychological and epistemological methods are not identical, no more than are anatomical and embryological.

The blending of these two problems is characteristic of the entire period of criticism to which Hume belongs. It was thought that the epistemological problem could be solved by undertaking a synthetic construction of the contents of consciousness from the elementary facts which psychological analysis had revealed. It was supposed that what was simple and ultimate in a psychological regard was also adequate to explain our perceptual and intellectual complexes. This is tantamount to asserting that a knowledge of the chemical constitution of a body is able to furnish us with a direct sensuous picture of that body. It would be the same as if an anatomist after singly studying and depicting the myriad parts of an organism should form a new synthesis of them and imagine he had apprehended in so doing the secret of life. Consciousness is an organism like the living body; not a mosaic that can be taken apart and then rebuilt from its elements on the same plan. In fact, we must go a step further and say, the simple, the elementary is never a datum, but is an abstraction—not a thing experienced but a thing thought. In actual experience, apart from all psychological reflexion, the elementary, or what Locke calls "simple ideas," never occurs. In point of fact, we have experience only of complexes, complexes of sensations of varying qualities and modalities, combinations of motions with sensations, combinations of sensation and motion with feelings and volitions—complexes in which some of the individual constituents suffer change and modification whilst others remain unmodified. These complexes are the original data of consciousness. We renounce all possibility of insight into the real foundations and epistemological value of our ideas if we regard these complexes or syntheses as the subsequent products of conscious activity whose origin from isolated elements is in need of some additional explanatory principle. This is a complete inversion of the situation and involves us in struggles with difficulties of which we ourselves are the creators.

That unification, that complexus which makes of a group of sensations a "thing"; that complexus which presents a causal relation—that is the simple original element for the non-reflecting consciousness. The separation of its constituent parts, the analysis of the complex into its elements is a work of thought, of abstraction. There is never in consciousness absolutely unformed matter, a raw material of sensation on which the mind imposes form from its own exclusive stores—for the simple reason that in the world which our sensations reflect no such thing exists. The ideas of matter and form are here as everywhere altogether relative. Thus also pure formal thought cannot be in consciousness entirely before experience, making possible experience itself; but consciousness by the exercise of reflective thought picks out from the unanalysed contents of experience what the early critical philosophy called ideas of form or *Stammbegriffe.* If these were not immediately contained in original data of experience, we could never arrive at knowledge by means of them, but at best could perform constructions. Hence the question regarding the bond which knits together our perceptual complexes, or regarding the source from which the form of our sensations springs, can only be understood from the point of view of a matured reflexion to which for some reason or other the immediate data of experience have been made the subject of doubt. The simple man, the man of early stages of civilisation, the adolescent man, would not grasp the question at all—it is extremely difficult even to make him understand what it means. For the perceptions by which formal conceptions, say the idea of cause and effect, are awakened in him are not distinct, detached, and isolated perceptions, but a complex of perceptions of which one always stands to the others in a relation of contiguity, of which one passes into the other or is transformed into it, and which for him, therefore, are not separated but belong together and form a whole.

The contents of the notion of causality in the natural consciousness, therefore, is something more than and different from what it is in Hume's explanation. Even the non-scientific consciousness discriminates quite readily between the inward compulsion of an association and the outward necessity of a relation of causality. Not everything that constitutes by reason of regular succession an association, a propensity to pass from one thing to another, is conceived as causally connected—a distinct proof that in Hume's explanation all the contents of the idea have not attained their full expression.

This explanation exhibits a surprising similarity to the exposition which a movement in modern psychology, resting on allied fundamental views and which is often also termed empiricism, has given of the origin of the perception of space. This psychological empiricism has attempted the feat of showing how spatial character can be imparted by sensations of movement to contents of sensation to which originally the spatial quality was wanting. But the muscular sensations of the moving eyeball could never engender the optical intuition of space unless the sight-sensations had from the beginning been definitely arranged and fixed in visual space—they can only give greater distinctness to this originally incomplete arrangement.

No more can habitual connexions of two objects or ideas through a relation of sequence produce the true notion of causality, as the general consciousness of mankind employs it, although as we shall see, in this notion regularity of temporal succession also forms a factor and that no inconsiderable one.

But the deepest root of the notion of causality has not yet been disclosed in the preceding considerations. So far, we have only marked out in the path trodden by Hume the place where this acute thinker strayed from the right trail. The natural complexus of sensations which we were constrained to substitute for simple ideas as the real epistemological element, is not of itself sufficient for our purposes. Natural complexes of perception also lie at the foundation of the notion of thing, of the notion of substance, of the notion of space and time, of the notion of the ego and the non-ego. The question is what additional elements must be contained in such a complex in order to engender the notion of causality, or, what is the same thing, to make the members conjoined in such a complex appear as cause and effect.

Our purpose may be made plainer if we reflect that man is not only a representing but also a willing being; not only passive but also active; that not only do the images of the world pass before his mental vision, but that he has also the consciousness of action, of interference, of independent creation, and of being a cause himself. In the notion of causality, as was said above, every one has in mind the notion of a change which has been effected or occasioned by an antecedent. Can it be, that the type of this idea is really so inapprehensible? Are we to think that all the changes in the objective world which emanate from the ego, as when we change the position of a thing, take something into our hand or throw it away, when we put food into our mouths, make something, or divide something, or put something together, when we make something sound or vibrate—that all these processes or changes in the objective world are not to be conceived as having been produced by the ego? Volition, motion, the feeling of force, change in the world of objects—which for the very reason that we are successively aware of them as conforming to the manner and direction of our motion and with the measure of our power, appear as an equivalent or as a transformation of our motion—here we have a complexus of perceptions, no member of which is isolated and distinct from the rest, but which are involved in continuous and constant transitions, exhibit partly spatial, partly temporal contiguity, which form an indiscerptible totality, and from which the individual factors can be disengaged only by extremely mature reflexion. But reflexion of this kind is foreign to the ingenuous man. Since not a shade of doubt prevails in his mind concerning the connexion of his movements with his power and will, and again concerning the connexion of a movement willed by him with the results accomplished before his eyes: consequently this event becomes for him in its entirety the type and exemplar of causality.

Effect, "effected," is that which one endowed with power makes, creates, or shapes by means of this his power. This is the real root of the notion of causality as man fashioned it previously to all science and theory of knowledge, through intimate contact with his needs and his abilities, and consequently with his instinct of self-preservation. Let us picture to ourselves but for a moment the importance for man of the changes produced in the outward world through his initiative power,—the slaying of enemies, of beasts of prey, the felling of trees, the manufacture of weapons, tools, utensils, the production of fire, etc.,—and we shall no longer be tempted to doubt that the strong impression which this relation must have made on consciousness was the first and most original source whence the notion of producing effects, of causal connexion sprang.

It has been held that we must dig deeper in order to lay bare the true root of the notion of causality, and that for this purpose reference must be had to certain phenomena of inward experience—the following of a conclusion from its premises, the desiring of means for the sake of the end that can be reached by the means. Here and only here, is necessary connexion, inward conjunction, effectedness, absolutely evident. We are concerned here, according to the unequivocal declarations of inward experience, not with habitual succession, but with genuine causation. Now unquestionably it must be granted that the connexion of these psychical processes answers perfectly to the notion of causality as that takes shape after a rigorous epistemological and critical elaboration. They are perfect types of psychical causation. But whatever services they may render in a logical or epistemological examination of the idea of causality, they are totally unqualified to supply the genetic foundations of this idea.

All development of consciousness proceeds from without to within. Man, in his earlier stages totally naïve and absolutely abandoned to the contemplation of objective things, learns only very gradually the art of scrutinising inward processes. Things interest him, not the consciousness of things ; the way things hang together, and not the way consciousness acts. The discovery of mind in his inner life must be relegated without exception to a subsequent stage. It is putting the cart before the horse to make the connexion of purely psychical phenomena the prototype of causality, the key to the changes of the outer world and the key to the understanding of what is effected by our will, by our power. Man is wont to take little notice of the formal character of these psychical processes, for the reason that he is concerned only with the result and its practical utility. The thought which flows from given assumptions, the willing of the means for the sake of the end, exist, by the sheer power of the psychical mechanism, merely and always when the appropriate conditions are given; but the mediating process itself is never made the object of search. Remotest of all, however, from the unspeculative mind is the idea of comparing these psychical mediations with the momentous changes which we produce in the outer world. So remote, in fact, that not even Hume, although he regarded many causal relations between psychical processes as something self-evident, e. g., the influence on ideas of the corresponding impressions, the production of belief and of passions by prospective events,—that even he never hit upon the possibility that the typical form for the connexion of events in outward reality inhered in the above adduced connexions between psychical processes, although he unquestionably recognised these as real.

Thus, the behavior of one of the acutest of analytical thinkers, Hume, proves how artificial and far-fetched is the attempt made by some modern psychologists to derive the notion of causality from purely psychical processes. Conversely, the history of the development of human thought proves, that the genesis here given of the notion is not a mere logical creation. Mythological thought—the first form in which man sought to rationalise the surrounding world of phenomena—shows that the experience of personal creation, personal activity, is the prototype of causality; that those transformations in the world which man himself does not produce, are first rendered intelligible upon his assuming the presence of acting Beings within them. The circumstance is also to be marked that these beings—the gods and demigods of all ranks and degrees—have never been perceived; and that consequently the human imagination had to execute here a difficult construction, had to perform a genuine act of creation in order to arrive at these mental fictions with which the intellectual history of all peoples, the crudest as well as the most gifted, teems. This circumstance itself proves that the root of the notion of causality cannot reside in the alleged psychical connexions. For, if the natural model of the notion of causality were really contained in these experiences of inward perception,—can it be imagined that human reason, whilst possessing such an implement for constructing and interpreting the connexions of natural changes, could have lighted at all on the expedient of personification ? Obviously, there is but one reason why the mythological habit of thought arose and established itself, and that is because no other connexion between results effected and the agent effecting them is primitively intelligible, except that where the effecting agent appears as the will and power of a person. Is the idea of God aught else in the minds of most people than the largest and hugest product of this naïve instinct of causality, which never rests satisfied until it is thrown back upon personal action and creation ?

And as a further proof that we are on the right track here, attention may be drawn to the fact that even where the idea of personal action has receded into the background, there is still a fair portion preserved of this ancient, I might almost say paleontological, notion of causality,—a portion the mere announcement of whose name is sufficient to bring home to every one its tremendous significance for human thought and its connexion with the idea of personal activity. I refer to the notion of force. No one will deny that we have derived this notion from self-perception,—whether from the force which we ourselves as willing persons exert, in order to do or accomplish something, or to produce certain changes; or from the impressions which we receive when outside things act on us. Whether active or passive, we are conscious of forces—now of our own force, now of outside force. And on the basis of this immediate experience we interpret as activity and passivity all those processes in the surrounding world in which we personally are not concerned in either of these forms. It is plain that force, too, is nothing but a weakened mythological personification. It is plain that a phenomenon is no more explained on tracing it back to a force than if we had traced it back to a deity. The ideas which accompany the thinking of the notion force are at best but an abridged expression of the facts themselves, of definite quantities of motion at definite points of the physical world. But the enormous diffusion and use of this notion in the thought and language of mankind, which even the terminology of science has not been able to avoid, affords a proof of how difficult it is for us to conceive of action and change in any other way than under the guise of activity and passivity, of a force that is exerted or of a force that is sustained. But this is the formula which in our immediate perception connects the changes of the outward world.

Here, too, it would be quite unintelligible how humanity had reached this mythology of the notion of force, which forms a well-rounded counterpart to the mythology of the gods, if the explanation of an otherwise unintelligible regular connexion between two phenomena had not appeared clear to it in these experiences, and if the psychological root of the notion of causality did not reside here, especially as regards the aspect of necessary connexion. For naïve thought, certainly, cherishes no doubt that if something is traced back to a definite force or exhibition of force on the part of something else, then that result necessarily follows—no more than it would for a moment cherish a doubt as to the necessity of the effects which are produced by its own displays of force.

Of course the phenomena which are to be explained by the notion of force must have a sort of resemblance to the changes which we ourselves produce; since otherwise the latter could not be used for their explanation. That is to say, they must succeed one another with the same regularity that certain modifications in the world follow upon the setting into activity of our representative or volitional powers, or upon our bodily movements, and we must be in a position to get some sort of direct view of the transformations, of the passing of one phenomenon into another, by the addition of some second thing. Where this for some reason or other is impossible, the naïve human being, the moment some modification appears to him of sufficient importance to be made the object of thought, again has recourse to mythology, and the activity of mysterious, invisible, personal beings is once more employed as a means of explanation, revealing the true and primitive root of causality.

We revert here to the factor of regular succession. By itself it is far from sufficient for engendering the notion of causality, yet it is proportionately indispensable in accounting for the rise of the same. Every regular succession produces an association of ideas, and the latter gives rise to an inclination to pass from the one idea to the other, or, when the one is given, to add the other in thought. But connexion by causality is a special case of the general form of connexion of ideas by succession. What it needs is a direct intuitive view of the transformation, and of the mode of emanation of things from one another, a direct and actual perception of the propagation of one state or property into something different. In a word: in and with the succession is given coincidentally the impression of coexistence and of contiguity, and this by virtue of the above-explained analogy with the results of our own action furnishes the foundation of our idea of things as being caused by, or due to, one another in addition to the fact of their following upon one another.

Now it is a frequent saying—Hume said it and countless others have said it after him—that in no case can we have a perception of this. This sceptical assertion, however, transfers doubts of a matured scientific frame of mind to the original construction of the idea. The common man would be quite astonished if we said to him he had no knowledge of the connexion, of the transformation which exists between fire and the production of heat, glowing, and burning, or which exists between nourishment and a certain degree of strength of body, between hunger and weakness, between rain and the prospering of plants, between generation and birth, between a blow, a wound, and death. We have only to reflect on what different demands exist for evidence or intuitive knowledge according to the degree of intellectual development. Things that appear quite natural and palpable to a simple mind offer the most perplexing riddles to developed thought. Man's appreciation of the continuity of a given connexion of things has many gradations from the most superficial and crudest to the microscopically fine and mathematically exact. That fire is the cause of the burning of objects with which it is brought in contact, that it "consumes" them as a man does a meal, was perhaps never seriously doubted by any one that was not a philosopher, nor ever held by any one for a habitual connexion of two impressions which have objectively nothing to do with each other. But connexion is not in all stages the same, nor is vivid and palpable intuition always the same. For primitive man the fire-myth was vivid and palpable; as was also for the beginning of scientific thought the theory of phlogiston—a substance supposed to be contained in certain bodies rendering them inflammable and which could be consumed by fire. For the way of looking at things which then obtained, this conception was vivid enough and remained so until new observations destroyed its palpable character and showed that burning was not a consuming of matter but an absorption and different distribution of matter, and until scientists finally got to understand the various possible re-arrangements of matter and the relation of generated heat thereto. Starting from this first fundamental insight into the transformative relations of natural processes, a succession of other thoughts subsequently arose which began to remodel entirely the relation of cause and effect as it had been hitherto understood. It was disclosed, that a cause really produces nothing, makes nothing, engenders nothing, but only gives rise to re-arrangement or transformation; that between two processes which subsist in the relation of cause and effect an invariable relation of equivalence obtains which is constantly under exact control; that in all so-called becoming there is actually nothing produced but simply something transformed or re-arranged, and likewise that in all apparent disappearance nothing really disappears but a definite form, a definite disposition and arrangement of the elements of reality.

From these ideas the modern scientific notion of causality has sprung. The doubts of Hume do not apply to this notion. Hume required of the notion of causality, on the ground of its involving the element of necessity, that it should exhibit in the *single* impressions the force which bound together cause and effect. To-day we can say that this is a complete miscomprehension. Whence could this isolated force of connexion be derived which is supposed to operate like a *Deus ex machina* between two things which by themselves have nothing to do with each other? The "cause" is force and the "effect" is force; and what is styled the causal relation is the fact that two forces are able when in contact to become transformed. This is not accomplished by means of a special force, but it is nothing else than the fact of transformation itself as related to the joint action of two forces. And this also offers us a simple explanation of why in some cases a single observation is sufficient to ascertain the existence of a causal relation between two phenomena—*videlicet,* in cases where the transformation of one phenomenon into another and the relation of equivalence between two forms of force can be rendered in some way evident and palpable; whilst in other cases hundreds of observations and the utmost regularity of succession are inadequate to this end, for the reason that it is impossible to establish that palpableness of transformation which can alone justify the employment of the notion of causality.

Scientific cognition when it asks for the causes of things is in quest of nothing but this evident and palpable connexion in which the properties of two things are mutually transformed when brought into contact. The simpler classes of these connexions are to-day quite clear to us, and the effort of science is now none other than to reduce also the most highly complicated of these connexions, such as the phenomena of life and of organic modification, to simple and immediately evident transformations. Even here the naïve conception of causality which reigned in olden times and which was characterised by the two concepts of creation and vital force or *nisus formativus,* has already begun to give way to a growing comprehension of the true connexions of this field. The history of the evolution of the plant and animal kingdoms enables us to understand the present world of organisms as the result of a long succession of transformations of organic forms throughout countless generations. For the mysterious and uncomprehended causality of creational acts has been substituted a knowledge of the chain of modifications and persistent states which have made of the developing organic world what it is—a knowledge which even now, as the outcome of an infinite aggregation of facts furnished by zoölogy, botany, and paleontology, has acquired almost irresistible distinctness and cogency.

Evolution explains the existence, the adaptiveness, and the astonishing functions of existing organisms by the summation of minute new-formations, which fundamental living forms have assumed through constant contact with their physical environment, and also renders intelligible a large number of these transformations by pointing to the particular circumstances which occasioned them. Physiology has arrived at the explanation of the large by the small on the same road through its discovery of the cell, or the organic element proper, which leads a life of its own wherein all the vital functions can be studied in miniature. We know that the individual animal, which we are accustomed to regard as a unit, is yet at bottom a multiplicity and constitutes a cellular colony, and that the functions of the single organs like those of the animal entire, are produced by the summation of the activities of countless cells. The old physiology sought to explain the actions of organisms, the character of whose transformations were as yet not understood, by the crude notion of vital force, precisely as the Ptolemaic astronomy assumed a special *spiritus rector* for each planet—all unmistakable indications of the true origin of the idea of causality. To-day the notion of vital force, as an empty mythological phantom, has in this department also been displaced by the notion of transformation. It is becoming more and more forcibly evident in matters of detail that the organism is nothing but an extremely complicated piece of machinery which under favorable conditions regulates itself. By its specially developed power of storing up potential energy in large quantities and of transforming the same again on slight excitations into kinetic energy, it awakens the false impression that it produces force from itself without the transformation of other force. But on closer examination it is found that the transformative process can be followed step for step; for in the organism, too, that invariable relation of equivalence between the different forms of force holds good which forms in a scientific sense the type of causality.

The employment of the notion of causality in human thought shows, therefore, a progressive development. Starting from the analogy of natural growth and annihilation with human action and creation, it appears everywhere founded on the existence of a definite connexion between two phenomena or changes which in some manner has been rendered palpably evident. The apprehension of this connexion, however, runs through all stages from the purely empirical to the rational, and from the inductive to the deductive. The contrast between mathematics and the sciences of fact which Hume pointed to, is not an absolute but a relative and graduated contrast. If it were absolute it would be unintelligible how we can make use of mathematics as a help in the study of physical things, but as this is instinctively done and with great profit to knowledge, profound analogies must exist between mathematical forms and the elements of reality, or, in other words, reality must involve rationality. On the other hand, the history of science teaches that matters of fact are always and everywhere the prime necessity,—and that even in mathematics. All elementary propositions of mathematics were first discovered as facts, that is, empirically observed, before they were deduced from axioms or were shown to be necessary. The same thing has happened with mechanics. Mechanics was originally a purely empirical science; to-day it has entered the realm of mathematics as a pure science. From the notions of force, gravitation, *vis viva,* mass, point of application, direction and velocity of motion, modern mechanics has developed a complexus of necessary truths concerning all possible forms of motion, and by means of the same physics has been rationalised throughout its whole extent,—that is, our physical knowledge, the connexions of physical phenomena, which originally possessed only a necessity of fact and were entirely empirical in character, have been converted into a body of knowledge which is linked together by the inward necessity of rational evidence and logical transparency. Chemistry pursued the same course. The bare empiricism of the old atomic theory which had been built up upon quantitative analysis and on ratios of weight and mixtures, is also beginning to give way before a deductive mode of treatment which attempts to deduce what were formerly only facts conjoined by empirical necessity, from funda mental assumptions involving spatial and mechanical data—from varying densities, heterogeneous occupation of space and irregular concentration of masses. And how long will it be before the biochemistry of the cell likewise will explain the present empirical fact of growth and modification of forms in all its inward necessity, from the constitution and *modus operandi* of the materials imbedded in the fundamental forms of organised matter?

The immanent necessity of logical evidence is for the modern mode of view in no respect something that is restricted to geometry, as Hume contended. It is simply most easily reached there, and consequently was earliest reached there. But we cannot make a thing that is the fruit of ages, viz., the notion of the necessity of causality in the above-discussed sense, the starting-point of the developmental process. We do have a development, but it is in the contrary direction,—the necessity which was originally only a necessity of fact is constantly raised in provinces of increasing extent to exclusively inward necessity. The problems of knowledge are solved when all provinces of action and of becoming are apprehended in their inward necessity.

FR. JODL.

PRAGUE.